Spontaneous Pneumoperitoneum

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SUMMARY

Spontaneous pneumoperitoneum most often occurs following ruptured peptic ulcer. In 80 to 85 per cent of cases of perforated ulcers, free intraperitoneal air is demonstrable. There have been reported three cases in which air was present without demonstrable cause, without peritoneal irritation or peritonitis. This presentation adds a fourth.

Examination of a patient with acute disease of the abdomen should include not only a roentgenogram with the patient supine but films made in the left lateral decubitus position and/or upright position to demonstrate free air. The radiologist should be ready and willing to consult with the surgeon at the time of examination. Attention is called to a sign described recently by Rigler in supine films, namely, the visibility of both the inside and the outside of the intestinal lumen. Another sign in the supine film, namely the contrast of air against the peritoneal reflections, is described.

PNEUMOPERITONEUM means simply free gas within the peritoneal cavity. It is induced therapeutically for pulmonary tuberculosis or tuberculous peritonitis or diagnostically to provide contrast for the intra-abdominal organs. The first mention of pneumoperitoneum in the literature was by Kelling[5] in 1902 who suggested its induction for diagnostic purposes. Many others since that time have treated this phase of the subject. This presentation will be concerned with spontaneous pneumoperitoneum.

Popper[11] in August 1915 first called attention to the possibility of pneumoperitoneum in ruptured peptic ulcer. Four years previously he had observed a patient with clinical symptoms suggesting peritonitis due to perforation, followed by spontaneous recovery. An x-ray study eight days following the acute episode demonstrated free air above the liver. In April 1915 Wieland[16] had found a similar sign in a patient with perforated ulcer, but necropsy showed that this radiolucent zone above the liver was due to transverse colon. In 1916 Lenk[6] observed the significance of free intraperitoneal air in penetrating wounds of the abdomen in soldiers. In the next few years many single cases of pneumoperitoneum were reported. During the past two decades a number of articles have been published reporting relatively large numbers of perforated ulcers in which the value of pneumoperitoneum in diagnosis was established.

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CAUSES OF SPONTANEOUS PNEUMOPERITONEUM

The most commonly recognized cause of spontaneous pneumoperitoneum has been that of perforated peptic ulcer. This is so important a cause that Johnson[4] in 1937 felt that spontaneous pneumoperitoneum was pathognomic of perforated peptic ulcer. Most observers who reported on the subject in the 1920s found that pneumoperitoneum could be demonstrated radiologically in from 81.8 per cent to 85.7 per cent of patients with ruptured peptic ulcers. A single exception was Warfield's[15] series of 35 cases reported in 1929 in which free air was shown in 43.5 per cent. He felt that the lower percentage was due to increased use of radiography and increasing acumen of the clinician. However, Thaxter's[14] report, which was published as recently as 1940, agreed with the majority of the earlier reports.

An analysis of the records at the White Memorial Hospital for the ten-year period from 1936 to 1946 reveals among 84,441 hospital admissions a diagnosis of ruptured gastric ulcer 41 times and of ruptured duodenal ulcer 18 times, or a total of 59 ruptured peptic ulcers. Of the patients with gastric ulcers 37 were men and four were women. Of those having duodenal ulcers, 17 were men and one was a woman. This is in keeping with the higher incidence of ruptured ulcers among males reported in all other series. In 20 of the 41 cases of ruptured gastric ulcer, radiologic study of the abdomen was made at the time of the perforation. Sixteen, or 80 per cent of the studies showed evidence of free intraperitoneal air. Of the 18 patients with perforating duodenal ulcers, nine had x-ray examination at the time of the perforation, and in seven of these cases, or 77 per cent, there was evidence of free air. These percentages agree well with those given by the majority of observers reporting on this finding.

Other less common causes of spontaneous pneumoperitoneum have been described. Among these are carcinoma of the stomach, typhoid ulcers, tuberculosis of the appendix, perforated appendix, rupture of distended loop of bowel following obstruction or trauma, perforation of stomach by gastroscope, perforating abdominal wounds, rupture of urinary bladder, rupture of colon diverticula, and "pneumatosis cystoides intestinalis." At the White

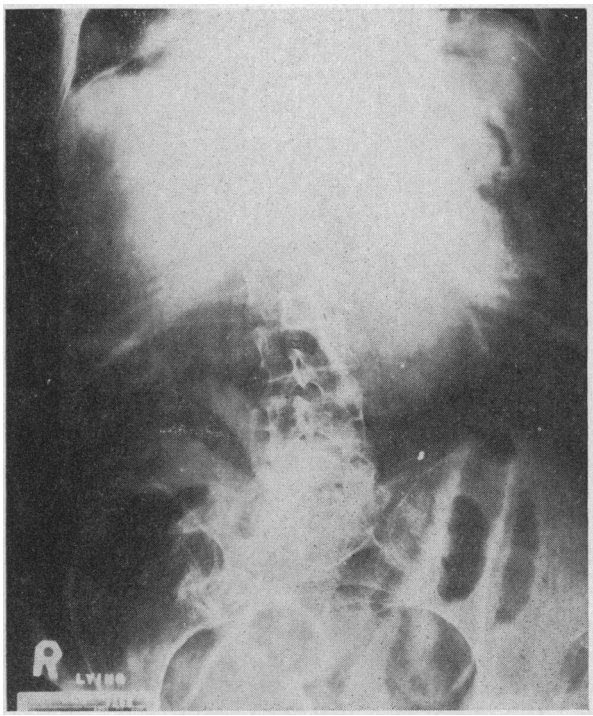

Figure 1.—The patient, an 86-year-old female, had a large rent in the stomach after eating a heavy meal. The exact cause was not found. Note, in the lower right, the large cecum with both inner and outer walls visible. This is a supine film.

Memorial Hospital, two cases of carcinoma of the stomach, and one case of perforation of diverticulum of the colon in which free air was demonstrated have been observed. Massive pneumoperitoneum was also seen in an aged woman who had an apparently spontaneous rupture of the stomach after a heavy meal (Figures 1 and 2).

To be considered in differential diagnosis is pneumoperitoneum which may be unintentionally induced. Some air almost invariably remains in the abdomen following laparotomy, especially if the surgeon has pulled up the anterior abdominal wall in an effort to secure the last suture. Pendergrass and Kirk[10] stated that air can be demonstrated for a period of 24 hours or more in 60 per cent of patients who have undergone laparotomy, and Rigler[12] stated that air may be observed for as long as three weeks following such procedure. Banyai[1] and others showed that pneumoperitoneum may complicate therapeutic pneumothorax in the treatment of pulmonary tuberculosis either by direct insertion of the needle through the diaphragm into the peritoneal cavity or possibly by way of the diaphragmatic hiati. It may also occur by way of the uterus as in the Rubin test, or the woman herself may induce it by the use of the bulb syringe or by using a gas-forming douche.

SPONTANEOUS PNEUMOPERITONEUM WITHOUT DEMONSTRABLE CAUSE

Hinkel[3] reported a case of spontaneous pneumoperitoneum without peritonitis, demonstrable visceral perforation or exogenous origin. He was able to collect only two such cases from the literature, one described by Moberg[8] and the second by Monod and Holiander.[9] In Moberg's case, the patient was an 81-year-old female with severe vomiting. Autopsy disclosed scirrhous carcinoma of the pylorus with stenosis but without perforation or peritoneal irritation. Monod and Holiander's case was that of a 35-year-old man with clinical signs of obstruction. At operation the gas escaped from the peritoneum with a hissing sound, but no peritoneal inflammation, intestinal obstruction, or other pathologic change was found. The patient recovered quickly. In Hinkel's case, the patient was a 70-year-old female with sudden severe pain in the epigastrium and lower chest aggravated by breathing. There was a history of dry cough for 15 years. The chest was limited in expansion and hyper-resonant on the left. The abdomen was distended and tender but not rigid. Roentgenograms revealed a large pneumoperitoneum below both diaphragms with elevation and some fixation of the left diaphragm. Roentgenograms following barium meal and enema were reported normal. Bronchography disclosed slight pooling of lipiodol at the left base against the elevated diaphragm. This pooling was thought to indicate emphysematous bullae. The patient was asymptomatic after two weeks, and was well one year later. The air remained in the peritoneal cavity for 21 days which suggested to Hinkel that the inlet remained open or reopened at intervals, since he thought the long duration precluded a single episode of air admittance. He felt that the emphysematous bullae at the diaphragm might have been responsible.

Rigler[12] described a patient in whom pneumoperitoneum was demonstrated on gallbladder films, but without material symptoms and without clinical evidence of perforation. Whether this truly represented a spontaneous pneumoperitoneum without demonstrable cause cannot be established as the patient did not return for further observation.

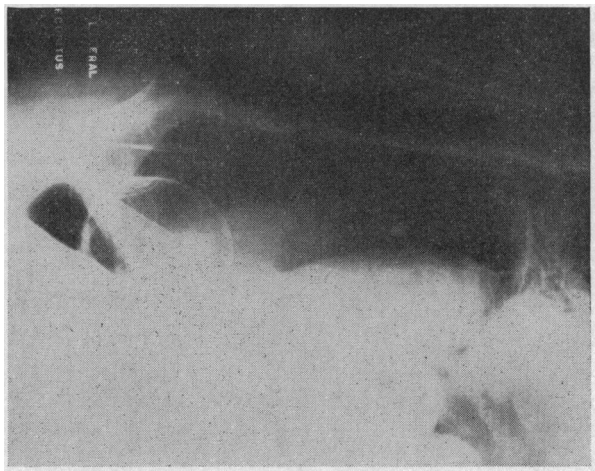

Figure 2.—Same patient as in Figure 5. Note the huge pneumoperitoneum. The balloon-like shadow at the left of the illustration is the cecum.

Maxfield and McIlwain[7] described a patient with spontaneous pneumoperitoneum found at fluoroscopy in a routine gastro-intestinal study. Five days previously he had suffered an attack of acute indigestion lasting for a few hours, followed by spontaneous remission and relief. A duodenal ulcer was demonstrated radiologically. This case may well be an example of what Singer and Vaughan[13] described as a "formes frustes" type of perforated peptic ulcer in which the symptoms quickly abate following the perforation, due, they feel, to rapid sealing or plugging of a tiny perforation. The patient had a demonstrated duodenal ulcer, so that it is possible for a small perforation to have occurred and quickly sealed itself.

To these reported cases of spontaneous pneumoperitoneum, for which the source of the air was not found, the authors would like to add an additional case.

CASE REPORT

The patient, a woman 81 years of age, entered the hospital complaining of increasing distention and abdominal pain for one week. The patient, when first observed, was semi-comatose and felt little pain. She had had previous similar, but much milder, attacks. The patient had a left inguinal hernia, and had had a stroke.

Examination: Upon examination, severe distention of the abdomen was noted. The abdomen was tympanitic and tense; no masses were palpable. There was no audible peristalsis, and the patient complained of no pain at that time. The blood pressure was 146 mm. of mercury systolic and 98 diastolic. Pelvic examination showed no evidence of pelvic masses. The leukocyte count on admission was 22,100 with 89 per cent neutrophils, of which stabs were 16 per cent. The urine showed a two plus reaction for albumin, numerous pus cells and occasional erythrocytes; no sugar or other pathologically significant components were found. X-ray examination disclosed a very large area of pneumoperitoneum visible even on the film taken with the patient supine (Figure 3). There was pronounced distention of the colon. An enema resulted in complete deflation of the colon as demonstrated on a subsequent film. The loops of small bowel could then be seen through the air, which outlined the peritoneal cavity (Figure 4).

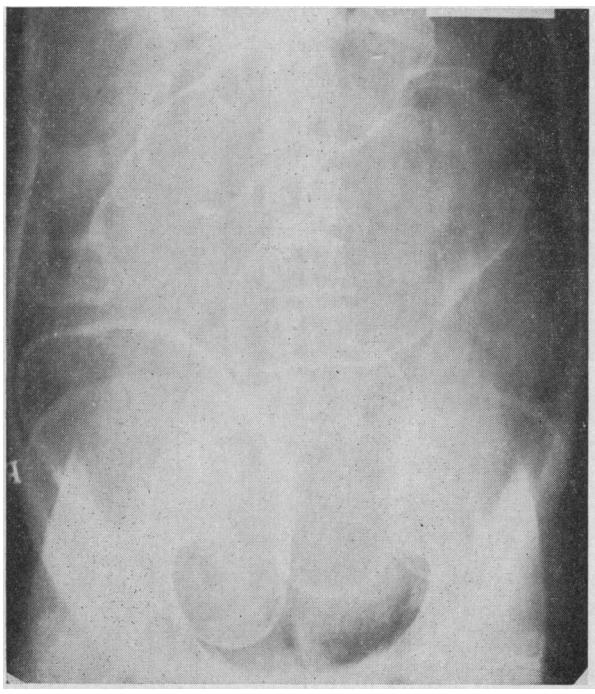

Figure 3.—Massive pneumoperitoneum in a patient without demonstrable cause (see text). Note the visibility of the outside as well as inside of the greatly distended large bowel. Note the air contrast along the lateral peritoneum. (Supine film.)

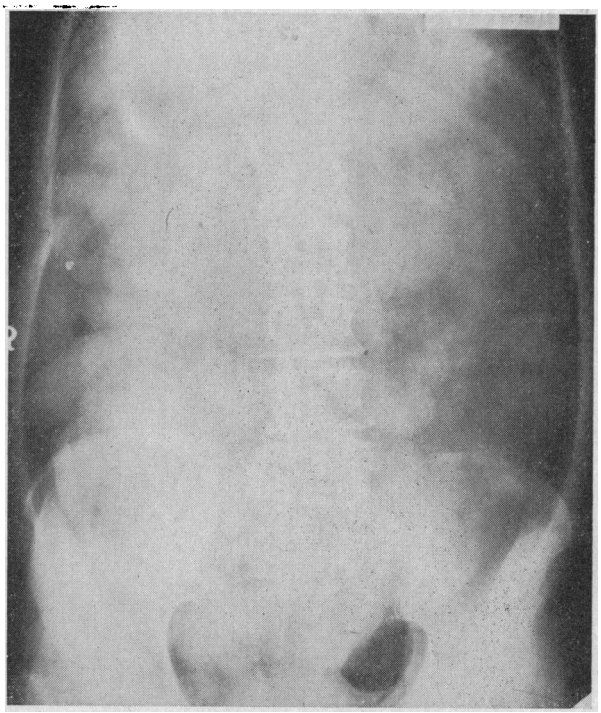

Figure 4.—Same case as shown in Figure 3. Deflation of the bowel after enema. The massive pneumoperitoneum is well seen against the lateral peritoneal walls. (Supine film.)

The surgeon stated that puncturing the peritoneal cavity was like puncturing a toy balloon. Large quantities of entirely odorless gas rushed out and the abdomen then became flat. The abdomen was gently explored and no evidence of peritonitis or free fluid was found. Both the stomach and the cecal area were explored. The small bowel and colon were deflated and small. The cause for the pneumoperitoneum was not determined. A culture made of a smear from the peritoneal cavity revealed an occasional Gram-negative bacillus which fermentation test identified as Escherichia coli.

Following operation, the patient received transfusions, and a Levine tube was inserted for feeding. The postoperative temperature record indicated a daily rise to approximately 100°. This febrile course continued and almost two months later a rectal abscess was drained.

Discussion: As in Hinkel's case, this patient was never very ill as far as the abdomen was concerned. She was old and senile, had had a stroke previously and was therefore slow in recuperating. There was evidence of infection in that the white count was elevated and the patient continued to run a low grade fever. This would suggest that there may have been a perforation in the pelvic colon not observed at the time of operation, and producing no peritonitis. It is to be pointed out, however, that the rectal abscess which probably caused the fever was extraperitoneal.

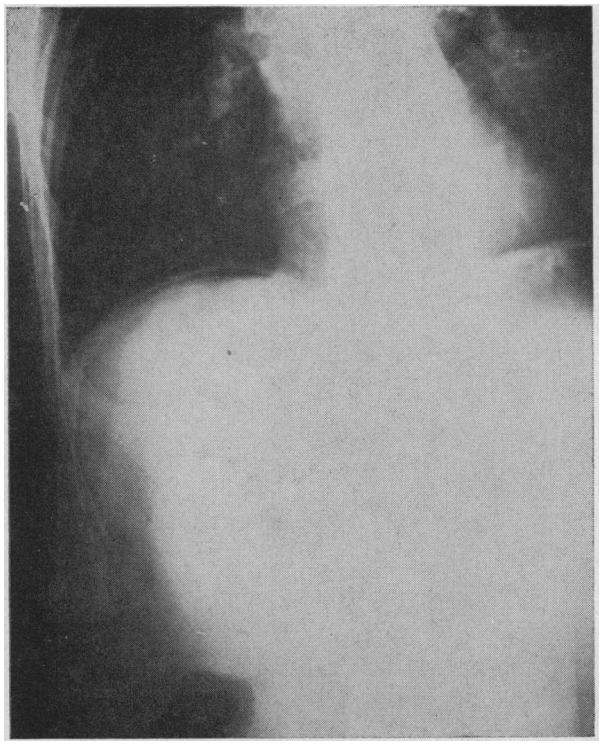

Figure 5.—Upright film of a patient with ruptured gastric ulcer. Note small quantity of free air between liver and diaphragm.

TECHNIQUE OF EXAMINATION

The practice of having the x-ray films of the "acute" abdomen reviewed by the surgeon at the time of the examination, especially those made at night, and not reviewed by the radiologist until his later convenience, is to be deplored. The roentgen examination of the "acute" abdomen is of such importance that it should be made under the supervision of the radiologist, who should also be willing to render an interpretation at whatever hour needed.

The day of the single supine film examination in cases of suspected acute abdominal conditions is past. Since ruptured peptic ulcer must be considered in most cases of acute diseases of the abdomen, study should always be made for the demonstration of free air. Classically, the film for this study is made with the patient standing, and this still remains the most widely used method for the demonstration of air. The film area should include the diaphragms; however, many patients are too ill for this procedure, and occasionally if the amount of air present is small it may not be visible by this means. Under these conditions, a left lateral decubitus film should be made. For this the patient is placed on the left side, remaining in this position for 10 to 15 minutes to allow small quantities of air to rise. The examination is made with the central ray directed horizontally and the film placed so as to include the right lateral abdominal wall and the right diaphragm. The advantages of this position over the upright view are: (1) The patient is more comfortable during the examination; (2) allowing the patient to remain on his side should theoretically make it possible to demonstrate smaller quantities of air; (3) this position will decrease the chances of further leakage from perforations in the distal portion of the stomach and duodenum; (4) it allows the examination of patients too ill to assume the upright position.

During the past several years, the practice at the White Memorial Hospital is to have all patients with the diagnosis of acute disease of the abdomen examined radiographically in three positions—flat supine, left lateral decubitus, and, if possible, upright.

X-RAY FINDINGS

The usual x-ray findings of free intraperitoneal air are well known. They depend to some extent on the amount of gas present in the peritoneal cavity. Friedman[2] thought that as little as 50 cc. of gas might be visualized on the radiograph. Rigler,[12] in working on cadavers, was able to demonstrate as little as 5 cc. of air, and with 20 cc. there was no doubt about air being present.

In the usual instance, it is not difficult to demonstrate a somewhat sickle-shaped rarefaction between the diaphragm and the liver representing the free air which has collected there. When there are large quantities of air the space between the liver and the diaphragm may be considerable. However, very small quantities of air are just as diagnostic as the larger amounts and should not be overlooked (Figures 5 and 6).

Rigler has described a sign of pneumoperitoneum seen in the supine films. This sign consists in the visibility of both the inner and outer walls of the bowel. It occurs only if there are large quantities of gas present. He described the sign as occurring most commonly in perforations of the colon. In the cases in which the authors have noted this sign, the perforations were in the stomach or duodenum. Another characteristic sign which is sometimes helpful has been noted, and that is the demonstration, in the lateral aspects of the supine film, of the

Figure 6.—Same patient as in Figure 5 in right lateral decubitus position. The free intraperitoneal air is seen laterally.

presence of air adjacent to the peritoneum or overlying the liver shadow (Figures 3 and 4). This is not as frequently seen, or as easily recognized, but when present should arouse suspicion of the presence of free air and lead to additional views such as the upright or lateral decubitus. It is well to keep these two signs in mind when viewing the supine film, since the authors have observed several cases in which the presence of a perforation was missed by competent radiologists who apparently were not aware of these signs or did not properly interpret them.

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Discussion by L. H. GARLAND, M.D., *San Francisco*

The diagnosis of pneumoperitoneum is relatively simple in well established cases, and the methods suggested by the authors are fully concurred in. However, differential diagnosis of very small amounts of air from collections of fat under the diaphragm is not always a simple matter. Projections in two different planes are of aid in reaching this differentiation.

For most patients with a clear-cut clinical diagnosis of ruptured ulcer, a single left lateral decubitus film made with a horizontal beam is usually all that is necessary. These patients need not be disturbed in order to make additional upright or supine films. However, when there is any question concerning the presence of free air, then additional views should be made.

We cannot share the authors' enthusiasm for bowel visibility as a useful sign. In the text of their article they point out that this is usually seen only with massive collections of air; it is therefore usually a late sign.

We have seen one case of idiopathic or cryptogenic pneumoperitoneum, that in a female who gave a history of taking vigorous knee-chest position exercises on the advice of a cultist. This finding was observed on two different occasions and needless to say caused considerable surmise.

As neither alimentary tract ulcer nor colon diverticulum was demonstrated, presumably the air gained admission via the fallopian tubes.

Accuracy in roentgenographic technique, plus consultation with the radiologist *prior* to the examination, will assure an even higher percentage of accurate diagnoses of pneumoperitoneum than is at present experienced. The authors are to be congratulated for emphasizing this point.